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Social and Political Conflict Over Dam Development on the Irrawaddy River

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Social and Political Conflict Over Dam Development on the Irrawaddy River

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Dedication

This work is dedicated to my parents, John and Sally LeNeave, for all of their love, support, and kind words over the years.

To Dad and Mom, thank you both for being my rock over the years. I most certainly would not be the woman I am or where I am today without you both in my life. All of my successes and motivations throughout the years I owe to you two. I love you both dearly.

Acknowledgements

I would like to acknowledge my family for their love and undying support throughout my academic career. Regardless of the circumstance, I can always count of them to be my number one “clappers” along the way. Also a very special thanks to the Puthoff family, Hal, Adrienne, and Collin, for all of their caring guidance, love, and laughter during this process. I cannot ever thank you all enough for everything you have done for me. Lastly, thank you to Dr. David Spence for his support and guidance.

Abstract

Social and Political Conflict Over Dam Development on the Irrawaddy River

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The University of Texas at Austin, 2017

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After decades of troubled economic, political, military, and social history, Myanmar is currently engaged in seven China-backed dam building projects, that will permanently alter the the Irrawaddy River, the country's largest river. The Irrawaddy dominates the ecology of 61% of the total landmass, as well as the socioeconomic climate, given the fact that this area currently is home to nearly half of Myanmar's population of 55 million people.

Through sociopolitical analysis, this paper examines the effects of dam development along the Irrawaddy River and the corollary potential social, economic, and political repercussions anticipated throughout the region. Presenting the current status of the river as the spine of this small nation (slightly smaller than the state of Texas), the author provides data detailing manner and degree to which the dams will alter, irretrievably, the river's role as a means to livelihood, food supply (fish, herd animals and

agriculture), and major transportation waterway, currently stretching 2,170 km (equal to the distance from Dallas, Texas to Washington, D.C.).

This paper takes a detailed look at the relocation requirements and the impact on a broad range of resources are reviewed. The dams are anticipated to result in massive deforestation, unsustainable fishing practices, destruction of key habitats, cessation of mineral prospects, and changes in land at the dam sites and across the margins of the river's altered course.

Myanmar seeks to establish hydroelectric power as its only power source by 2030. Yet, as the data clearly show, other aspects of the risk/reward ratios emerge in the project's evolution. Myanmar currently is one of the most impoverished and underdeveloped countries, with socioeconomic gaps among the widest in the world. The dam projects are certain to further exaggerate these disparities. The paper takes up a discussion of these issues, both from historical and future-oriented viewpoints.

Antecedent to the scope of this paper, the author calls for further analyses using a range of robust socioeconomic models to assess future hydroelectric harvesting projects in underdeveloped countries which divert these hydroelectric resources to mega-power nations, with specific attention to the impact on resources, population relocation, and political/economic/social implications.

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Chapter One: Introduction

1.1 Myanmar and Its Greatest River

Located within Southeast Asia, the country of Myanmar (formerly known as Burma until 1989) is one of the least developed countries in the world with the widest range of ethnic diversity (CIA). It shares a 2,100-km boundary with China on the Northeast side of Myanmar (Weatherby 2012). The country covers 677,000 km^2 of land – slightly smaller than the state of Texas – with a population of nearly 55 million people. The Irrawaddy River, also known as the Ayeyarwady River, is located fully within the national boundaries of Myanmar and, currently, is one of the only major rivers in Asia that remains undammed on the main channel.

The Irrawaddy River flows approximately 2,170 km (the distance from Dallas to Washington D.C.), from its source point at the confluence of the N'mai and Mali Rivers (originating in the Himalayas), to the end of its journey in the Gulf of Martaban within the Andaman Sea (Figure 1). Over that distance, the Irrawaddy holds approximately two-thirds of the entire surface water volume for the country (Kravtsova et al. 2008). The basin of the Irrawaddy encompasses 60% of the total land area of the country with nearly 26 million people, nearly half of Myanmar's total population, currently residing within the basin area. By all measures, the Irrawaddy River is Myanmar's most valuable social and economic resource.

Figure 1: Map of Myanmar (CIA)

No consideration of the country and its resources is complete without an understanding of the socioeconomic aspects and the further implications of river issues directly impacting the life and well-being of the population. As the least developed country in the region, Myanmar is calculated to have a Human Development Index (HDI)

of 0.556 for its ranking of 145 out of 188 countries (UNDP; figure 2). The significance of Myanmar's current status of underdevelopment is particularly significant given the fact that growth and technology developments have less impact, or worst case, often sometimes greatly exacerbated disparities, in countries with high existing levels of inequalities (Dabla-Norris 2015). Myanmar currently is in a state of great impending changes and inherent threats from the potential implementation of major dams, escalating deforestation, unsustainable fishing practices, changes in land use, destruction of key habitats, and mineral prospecting (Simmance 2013).

	Human Development Index (HDI)
	Value
HDI rank	2015
145 Myanmar	0.556

Figure 2: HDI ranking for Myanmar in 2016 (UNDP 2016)

The government is pursuing an overarching goal of making hydropower the premier and eventually the only source of power, by 2030 with the potential to sustain 40,000 MW (Simmance 2013). Yet, notable in goal and in these figures is the fact that Myanmar has one of the lowest levels of electricity consumption within the world as well as among developing countries at 165 kWh per capita (Hennig 2016). The overlying reasoning behind the proposed implementation of six dams along the upper tributaries of

the Mali and N'mai Rivers that feed into the Irrawaddy River and the major Myitsone dam at the confluence of the Mali and N'Mai rivers, is specifically that of meeting all of Myanmar's national needs, while exporting up to nine times its own needs to the highly-developed industrialized nations in the region, most notably to China (Figure 3).

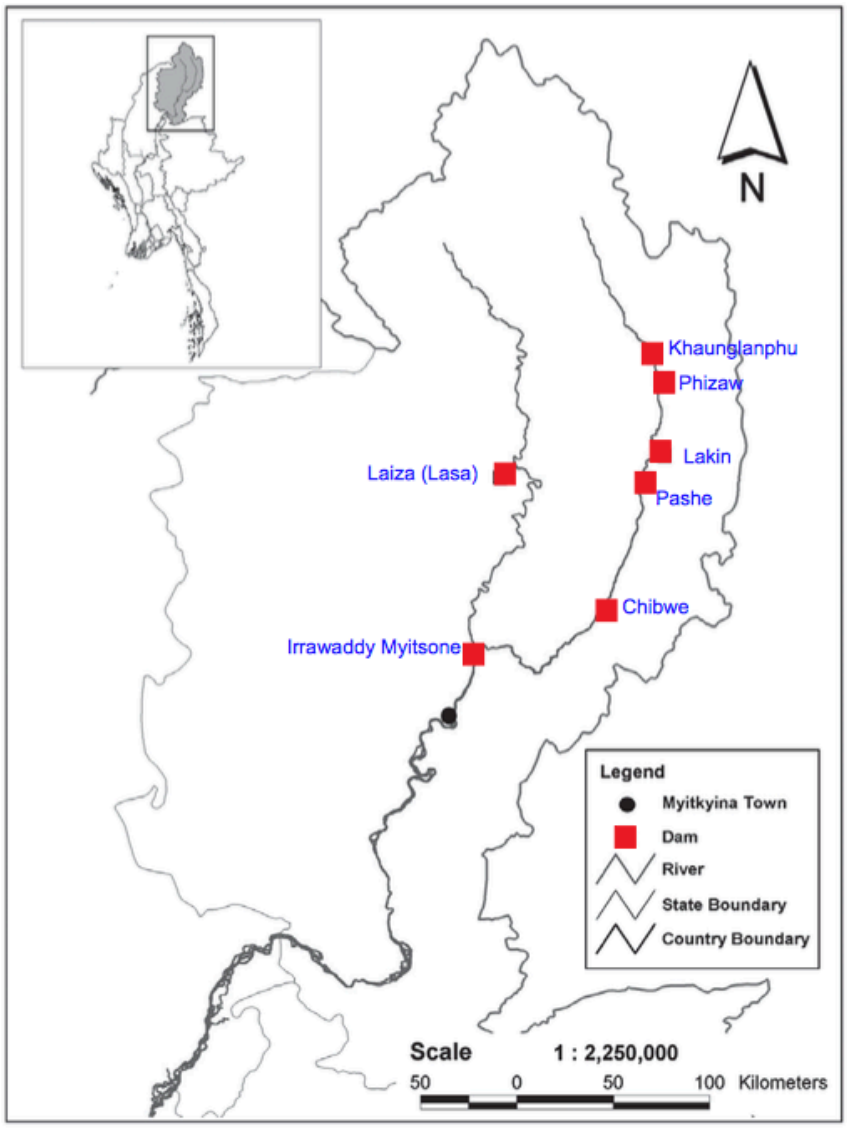

Figure 3: Map of the seven proposed dams along the Irrawaddy River (KDNG 2009; Simmance 2013)

1.2 Proposal

Myanmar is home to some of the largest and most controversial endeavors in the area of hydropower (Hennig 2016). The impact of these dam projects along the Irrawaddy River – seven proposed to date – cannot be underestimated. From multiple perspectives, the overall socioeconomic, political, agricultural, and resource-destabilizing consequences are staggering. These factors, taken individually and in the aggregate, are the focus of this study.

The appropriation of the great river of Myanmar will irretrievably determine the course of the indigenous population, nearly half of whom depend on the river's course as it now exists. While the export of 80-90% of the hydropower from these proposed dam projects greatly constrains Myanmar's future, the dam projects themselves bring other challenges and potentially-destabilizing unknowns, all of which greatly limit Myanmar's opportunities for decreasing inequalities, increasing political stability or promoting advancement beyond its undeveloped status.

Not only is the anticipated 80/20 or 90/10 hydroelectric export ratio poised specifically to deny Myanmar the opportunity to lay claim to 80-90% of its own hydropower resources, but distribution of this new wealth is likely to increase the great disparities – social, economic, political and educational – that currently exist, and further forestall any realistic bid to change its third-world status. These factors of increasing disparities are not unique to Myanmar or to the appropriation of massive amounts of resource exports such as hydroelectric. In the context of the Irrawaddy River and Myanmar's current underdeveloped condition, we see ongoing challenges wrought by an

indigenous population that has been bound to the river and the adjacent land for its subsistence, whether for transportation and fishing, agriculture and food production or the products of its adjacent forests. Over generations, these factors have kept the population surviving (at the margins of the birth and death-rate curves), and exhibiting classic features of subsistent population with minimal education.

Not surprisingly, these disparities either will be left unaffected/unimproved or, by nature of dislocation and disruption, be exacerbated. Impacts of disparities arise simultaneously from the inequality of outcomes (wealth, income or expenditure) as well as the inequality of opportunities. These macroeconomic factors present us with the question of who directly benefits from the wealth-producing activities and for whom the opportunities either expand or contract (Dabla-Norris 2015). As often noted by multiple sources, the rising influence of the rich and the stagnant or diminishing conditions of the poor have causal effects on crises and, thereby, curtail short- and long-term growth (Dabla-Norris 2015; UNDP 2014; Pasquali 2012).

As we examine the wide-ranging changes and the potential economics of the dam projects along the Irrawaddy, the question naturally follows as to 1) who is likely to benefit from the power-generating economics of the dams and/or the financial benefits from the export of large percentages of hydroelectric power (export estimates between 80-90%), and 2) if the export-generated revenues or dam-related technology would offset local losses by local gains, thereby counterbalancing the economic threats to the people adversely effected, those whose livelihoods and survival are derived from the river commerce, the adjacent agriculture or the fishing. An overarching principle relevant to

this question is the fact that dams and hydroelectric power, by their technical sophistication, involve high technology and technology growth. On the economic stage in any underdeveloped nation, high technology, in any sector, increases joblessness for all skill levels (Leung 2015). Heightened concern for Myanmar includes the fact the macroeconomic reality that inequality harms overall growth and worsens the chance of reducing poverty, factors which combine to present a lasting threat to long-term social or economic development (UNDP 2014).

Countless other undeveloped countries have preceded Myanmar in similar situations when conquering, colonial or more developed, self-serving powers have introduced higher technologies while laying claim to and exporting natural resources for their own gain. We have seen this situation numerous times before with other resources as the target: the oil curse, gold, land, lumber, and nearly all plentiful, desirable resources that present themselves. Now we are seeing it with hydroelectricity.

Not only will building dams fundamentally alter 61% of the land and reassign nearly half of the population to unfamiliar locations and unknown reconfigured environments, but the act of exporting 80-90% of the newly-produced hydroelectricity will put a hard ceiling on the further development on this region. To understand the full picture, one must examine the region in its entirety: its people and their indigenous culture, its climate, land use, struggles with deforestation, agricultural influence, and the geomorphology of Myanmar's highest water discharging and most expansive river, the Irrawaddy.

Chapter Two: The Region

2.1 Climate of Myanmar

To appreciate the impact of the dams of Myanmar, it is imperative to evaluate the climate of the region as this dominates the surrounding productivity of farmlands, water availability, seasonal growth cycles and other life-sustaining resources and processes. As a country Myanmar exhibits high variance dependent on two significant factors: geographical location and time of year. In terms of precipitation and climate variances, Myanmar can be divided into five distinct homogeneous geographic regions: North, South, East, West, and Central Myanmar (Sen Roy et al. 2000; Figure 4).

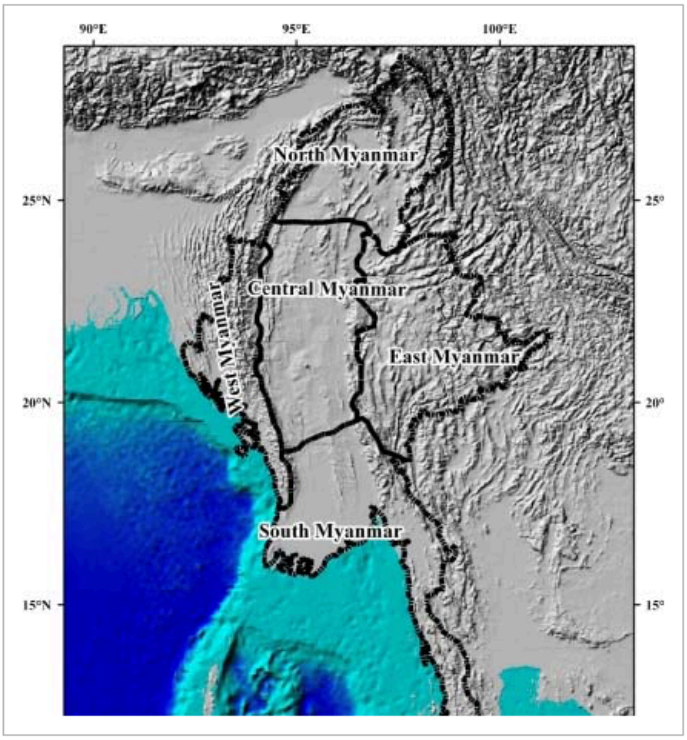

Figure 4: Homogeneous Regions of Myanmar (Sen Roy et al. 2000)

These regions differ primarily in fluctuations caused by the El Nino Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) events. The PDO consists of lengthy warm and cold phases that are not constrained to any singular decade of time, but rather can span several decades. With the presence of the PDO, there is a resulting amplification in the effect of the warmer phase of ENSO (Sen Roy et al. 2011). Simply stated, the climate effects compound each other. Climatologists liken this to a warm tropical period. An example of this would be the reported 10% decrease in precipitation in all regions of Myanmar during the El Nino years (Sen Roy et al. 2011). However, there is an overall "modulating effect" on the monsoonal precipitation across the country, with a larger effect throughout the colder phases of the PDO, and more specifically within the reaches of southern Myanmar. This observation compels a more detailed account of the rainfall of Myanmar (Figure 5).

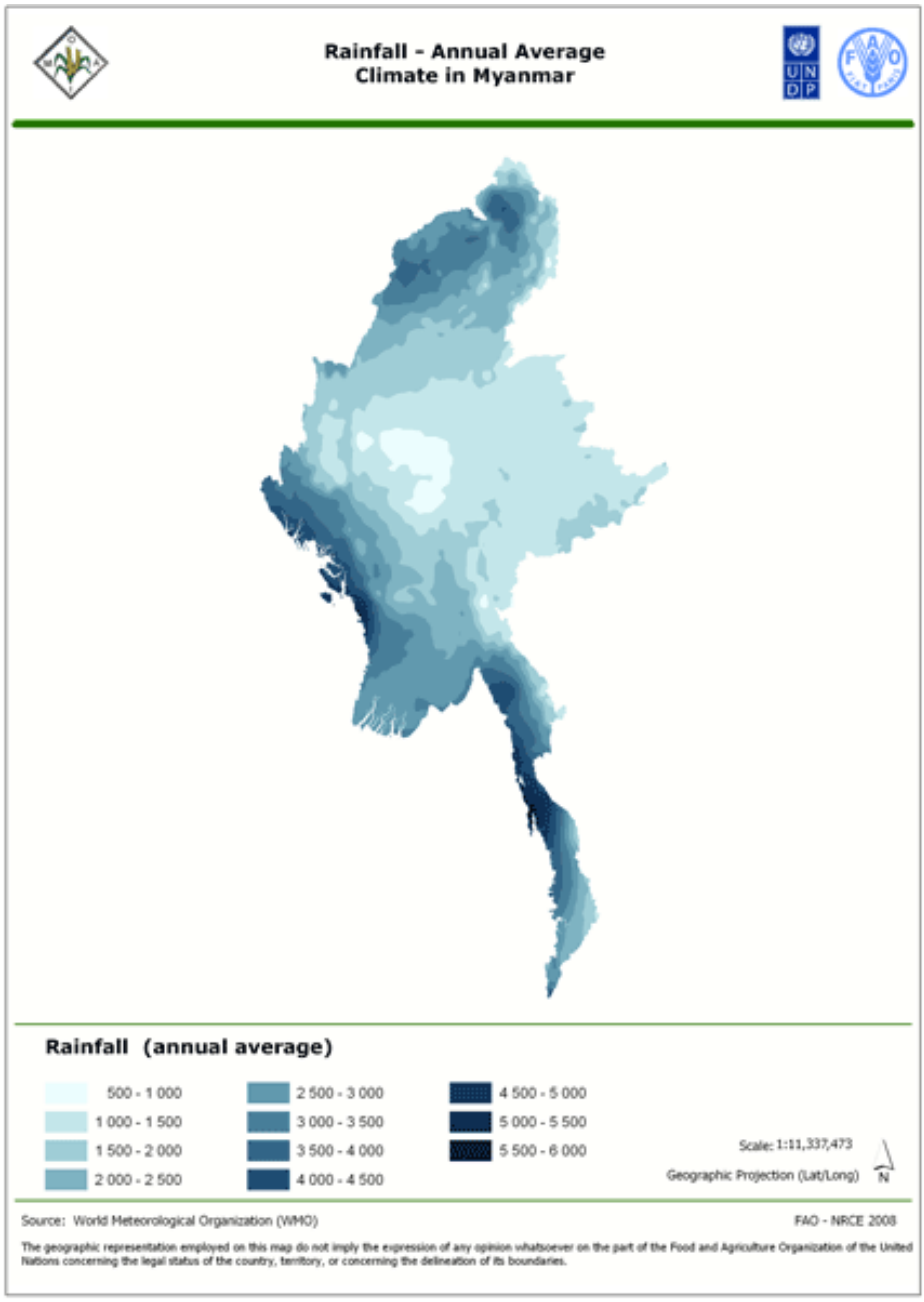

Figure 5: Annual Rainfall Distribution for Myanmar (mm) (FAO 2009)

Myanmar has three different tropical climatic seasons: a rainy season from mid-May to mid-October, a cool winter season from mid-October to mid-February, and a hot summer season from mid-February to mid-May. The rainy season from May to October brings approximately 75% of the total annual rainfall for the country of Myanmar (Sen Roy et al. 2000). During the month of August, the country sees its highest levels of rainfall: approximately 1,790mm as a yearly average over a 33-year period) and in July just slightly lower levels.

By contrast, the more localized area of the Irrawaddy region averages approximately 580mm in the month of August (Sen Roy et al. 2000). There is also notable variance in precipitation levels between the central and the coastal zones of the country, ranging from the smallest averages of 600mm to 1400mm in the central zone, to the maximum of 4000mm to 5600mm in the coastal zone. However, the precipitation levels typically lean to maximum amounts near the western coastal region and in northern Myanmar (Sen Roy et al. 2000).

2.2 Rivers and Mangrove

In addition to the Irrawaddy, Myanmar is laced with a vast number of river networks: the Salween River, the Chindwin River, Sittaung River, Shweli River, and Yangon River, to name a few. Mangroves are characterized by densely-populated tree and shrub growth, characteristically marked by large tangled root structures that protrude above the water. Tidal areas are pools of highly-fluctuating water levels that possess high salinity levels due to water evaporation. Mangroves are one of the most important

vegetation elements within tropical river deltas. Mangroves provide stabilization factors due to sediment trapping, along with assisting in the formation and further stabilization of sand bars in the shallow waters; mangroves also provide overall protection from large storms (Hedley et al. 2009). In addition to these delta mangroves stabilizing and preventing soil erosion, the mangrove systems surrounding the banks of the Irrawaddy River produce fuel wood and charcoal (Oo 2001).

Despite these strong positive attributes of mangrove systems that maintain environmental stability, mangroves are facing steady decline as humanity continues to overtake natural resources for other uses. The Irrawaddy basin is particularly vulnerable to accelerated mangrove forest decline as reflected in increased agricultural use for rice production, as well as the harvesting and clearance of mangrove forests. This mangrove decline has the further potential to seriously affect the vulnerability of the region in terms of stark economic change due to loss of fisheries in addition to river stability itself, as reflected in change of sediment load, flow variations, and water quality.

In the 71-year period, 1924-1995, the mangrove population decreased by nearly 25%, from 2345 km^2 to 1786 km^2 (Oo 2002; Hedley et al. 2009). Near the floodplains of the Irrawaddy River, there are no less than 29 different areas of associated delta mangrove species, making it one of the largest mangrove forests in Asia (Oo 2001). However, despite the impressive coverage, the Irrawaddy mangroves continue being heavily cleared and drained specifically to accommodate other uses of the land, all of which are contrary to mangrove growth as the human population encroaches on both the river and its banks of mangrove forests

2.3 Deforestation

When analyzing implications involved in dam building, it is important to note a more current status of deforestation in the region as the transition from forested land to agricultural and industrial land are the two main contributing factors for an increased rate of deforestation (CEF). Poverty, dense population distribution (such as relocation), and unequal land access are known to be the main underlying accelerators for man-made deforestation rates (CEF). Deforestation can be defined as the conversion of forested land to non-forested land and has the immediate impact of creating an ecological imbalance and a decline in biodiversity (CEF).

A large part of the deforestation rate as well as the degradation of forests is attributed to the extraction of natural resources, specifically in commercial pursuit of fuelwood and other forestry products. This factor is particularly prevalent in the region of Popa Mountain Park (Htun et al. 2012). Furthermore, as Myanmar's forests decrease, charcoal production, logging, and plantation development are on rise – all of which cumulatively taxes and extends the environmental degradation in process in the Irrawaddy delta region (Leimgruber et al. 2005; Figure 7). Myanmar's deforestation rates tops out at approximately 47% as of 2010, declining from 49% in 2005 (Htun et al. 2012; FAO 2010).

Despite the slight 2010 decline, Myanmar still retains one of the highest deforestation rates for any tropical environment. The exact rate of slowed, continued, or growing deforestation will inevitably fluctuate due to a multiplicity of varying factors ranging from natural to man-made influences. However, the sustained trend remains

prevalent: deforestation rates appear to stem from a quick increase in human population and the demand for natural resources.

Another component of the deforestation trend, which is an additional contributing factor to the increase in deforestation rate, is evidence that within closed forests there has been a change from gentle slopes to more steep slopes (Htun et al. 2012). It is important to note that, while Myanmar faces decreases in forest coverage, the region retains its status as having some of largest forests in Southeast Asia (Leimgruber et al. 2005). Despite this fact, Myanmar as a microcosm has succumbed to a net forest coverage decrease of 9,000 km^2 (0.2% annually) from the 1990s to the early 2000s (Leimgruber et al. 2005). Of these findings, there are a multitude of hotspots that have higher concentrated rates of deforestation within its borders.

Two key hotspots are the Irrawaddy delta region with a deforestation rate of 2.2-3.3% annually and the east bank of the River at 0.4% annually (Leimgruber et al. 2005). These examples of deforestation rates corroborate the fact that the mangroves near the Irrawaddy River have decreased 20% over a mere 10-year span (Leimgruber et al.2005). This is a strikingly large decline of mangrove forestation, over a single decade, that solidifies the briskly changing environment along the Irrawaddy banks.

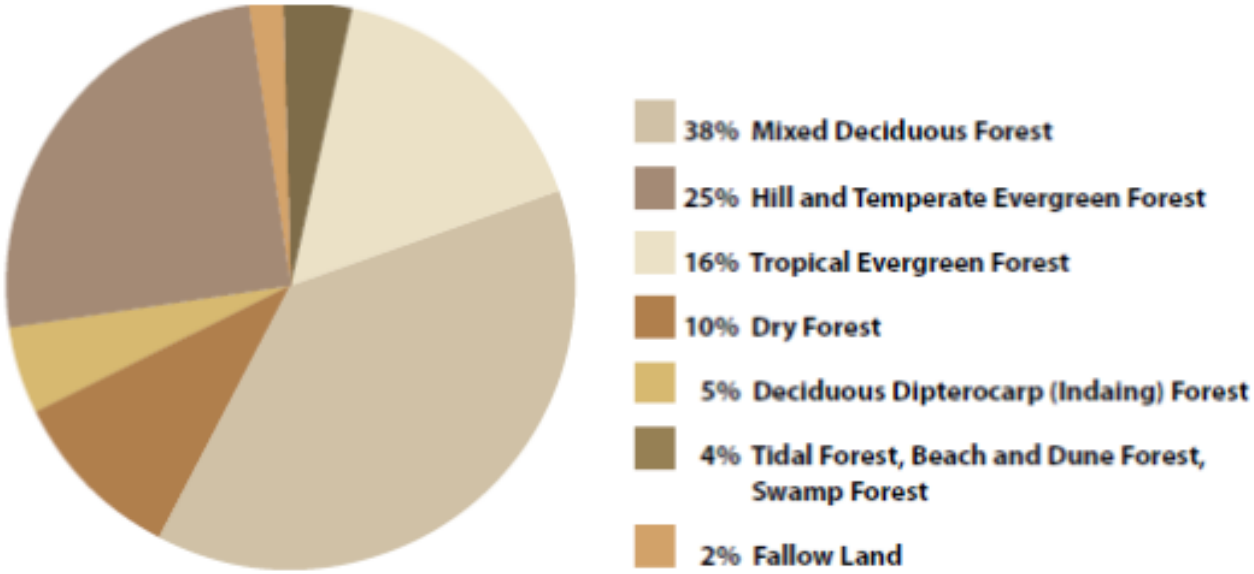

Figure 6: Breakdown of Forest Types (Instituto Oikos et al. 2011)

Division/State	*Total area (1000 km²)*	*Forest cover (1000 km²)*	*Forest cover (%)*	*Average annual deforestation rate (%)*
Ayeyarwady Division	34	9	26	1.2
Mandalay Division	37	11	31	0.5
Sagaing Division	96	62	66	0.4
Yangon Division	10	1	13	0.2
Rakhine State	35	25	74	0.2
Shan State	157	116	76	0.2
Magway Division	44	14	31	0.2
Kachin State	89	76	89	0.2
Tanintharyi Division	42	31	75	0.1
Bago Division	38	18	47	0.1
Chin State	37	31	87	0.1
Mon State	11	5	45	0.1
Karen State	30	24	78	0.0
Kayah State	12	8	74	0.0
Total	671	430	65	0.2

Figure 7: Percentage of Deforestation within Regions of Myanmar (Leimgruber et al. 2005)

2.4 Agricultural Elements: Fishing and Farming

To understand the composition of land and the role agriculture plays within the borders of Myanmar, one must examine land use. Myanmar land use is composed of three subcategories: agricultural land that accounts for 19.2% of land mass; forested land, 48.2% and "other" at 32.6% respectively (CIA). Agricultural land is distinguished by four subcategories, comprised of arable land (16.5%), permanent crops (2.2%), and permanent pasture (0.5%), and the "other" category of land use that also contains the 22,950 km^2 of irrigated land (CIA). While agricultural land comprises nearly 20% of land use, Myanmar's densely forested areas remain central to industry. Covering almost 50% of Myanmar, one of the region's strongest economic tenants is timber production, solidifying forested areas as one of the most important sources of income (Htun et al. 2012).

Over the course of countless generations, the people of Myanmar both depended upon and have adjusted to the seasonal cycle that impact the river in terms of fishing, agriculture, and transportation. With the introduction of dams, the river's seasonal cycles will be notably modified and require all those living off the land to greatly adjust their traditional way of life.

2.5 Conservation Areas

One must also note the importance of conservation and the relevant role it has in protecting the land, water, and the species which live in Myanmar. Between 1918 and 2007, there have been 33 national parks and wildlife sanctuaries created (Sovacool 2012,

Simmance 2013; Figure 8). The creation and expansion of these conservation areas are not only significant in the protection of species diversity, but also aid to reduce and control deforestation (Htun et al. 2012). There are two conservation areas that are specifically geared towards the preservation of fish: the Binlangjiang Aquatic Germplasm Resource Protection Area and the Tongbiguan National Nature Reserve (Yang et al. 2016). The Binlangjiang Area was started in 2008 and then resized in 2012 to spread over 1343.5 hm^2 around the Daying River with the intention of protecting the fish species within the Irrawaddy River.

The Tongbiguan Reserve came about in 1986 and was combined with the Ruili River Nature Reserve around 2009, becoming an official reserve in 2013 and working to shelter endangered, rare, and endemic fish species (Yang et al. 2016). An additional conservation area is the Popa Mountain Park, centered around the only extinct volcano in Myanmar. Popa Mountain Park covers a span of 100 km^2 and of that, 88.7% is masked by forests (Htun et al. 2012). Of the forested region in the Popa Park conservation zone, the majority consists of dry mixed deciduous forest (Htun et al. 2012). While all conservation activities are impressive movements to guard Myanmar's resources, the largest protection area within its boundaries is the Hukaung Valley Wildlife Sanctuary. This wildlife sanctuary established in 2001, now includes an extension added in 2004 which brought the sanctuary area to a total of 22,000 km^2 (Instituto Oikos et al. 2011). This area protects endangered tigers and threatened fowl.

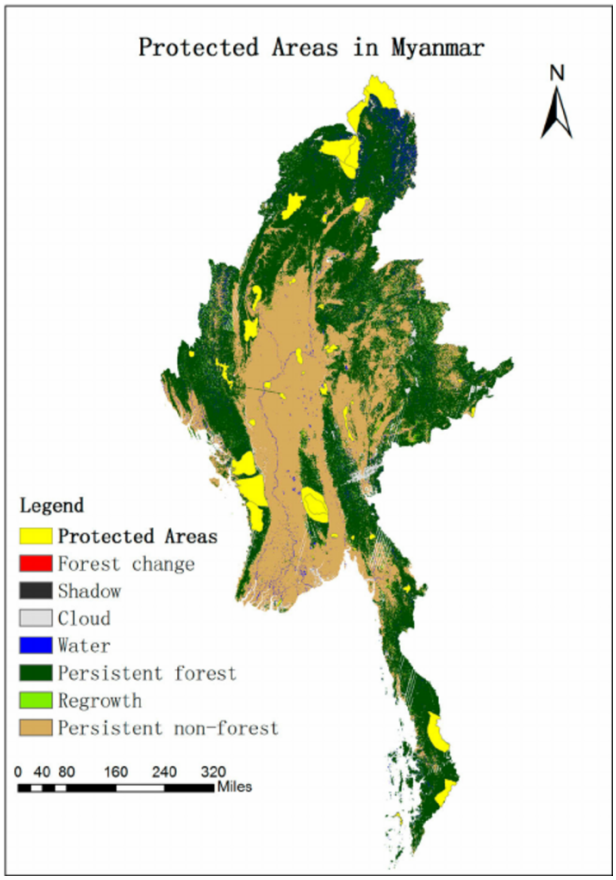

Figure 8: Protected Areas in Myanmar (Lio 2015)

2.6 Livelihood Along the River

Myanmar has a population density of approximately 73 people per km^2 with a majority of the population living on or in proximity to the Irrawaddy River (Simmance 2013). Not surprisingly, the people of Myanmar depend heavily on the Irrawaddy in several ways. Boats move goods and services (products and people), while markets and fisheries depend on the daily catch. Additionally, surrounding lands depend heavily on irrigation for farming.

Chapter Three: The Irrawaddy River

3.1 Delta Characteristics

As is well understood in the geomorphology of rivers, river deltas are in a constant state of change due to the shaping and evolution they endure from the earth elements as well as the introduction of anthropogenic changes in land use. By sheer size and flow and the fact that it collects two-thirds of the surface water of Myanmar, the Irrawaddy river delta earns its place as one of the major tropical deltas within the Southeast Asian region. This considerable resource lends itself to the high human population as well as well-established agricultural uses surrounding the river. One cannot underestimate the Irrawaddy's impact on the surrounding life.

The wedge-shaped distributary Irrawaddy River delta is totally contained within the boundaries of Myanmar. The delta extends down to 640 km from the coast of Myanmar and has a catchment area of approximately 0.7×10^6 km^2 (Robinson et al. 2007). The coastline of the delta has been stable since the mid-1800s and is progressing seaward at a rate of approximately 0.34 km per century (Hedley et al. 2009).

Not only does the Irrawaddy basin house a vast area of unprotected wetlands, but the region itself has one of the highest population densities in Myanmar (Salmivaara 2012). Wetlands provide incalculable benefits of environmental services that protect the river, its fish life, and other important habitats. High-population growth within the southern tropical rainforest lowlands coupled with the central dry forest lowlands create a sensitive and highly-vulnerable area within the basin, given accelerated population

growth estimates (0.73-0.89% between 2005 and 2050) and decline in forested area (Salmivaara 2012). The full human engagement on the river and its surrounding areas is evident, and provides compelling evidence for the importance of the river itself and the peril of deforestation, altering wildlife habitats, decreasing species, and increasing salinization of the bay in which the Irrawaddy feeds (CEF).

All rivers are dynamic focal points of life; the Irrawaddy River, as one of the great rivers of Southeast Asia, is a preeminently important example.

3.2 River Geomorphology

The Himalayan Mountains form the head waters for the N'Mai and Mali Rivers which merge north of the town of Myitkyina to form the Irrawaddy River. The Irrawaddy River flows steadily through Myanmar over the course of 2,170 km at approximately 160 meters above sea level with only miniscule change in elevation (approximately 8.4 cm/km) from the head to the mouth in the Andaman Sea (Kravtsova et al. 2008). The basin of the river takes up around 60% of the entire country of Myanmar and extends 1,500 km and spreads out over an estimated average width of 280 km (Kravtsova et al. 2008; Figure 9).

The maximum flow of the Irrawaddy River system begins in the summer monsoonal months when the Himalayan Mountains meltwater begins to flow (Kravtsova et al. 2008). During this period, the region sees its highest rainfall levels of the year and the span of months from July to September can account for 53% of the year's total (Kravtsova et al. 2008). Its highest rainfall month is typically August at 18.2% and its

lowest being February at 2.2% (Kravtsova et al. 2008). This large difference in rainfall leads to much seasonal variation in the water flow regimes (Kravtsova et al. 2008), similar to that of other often-studied rivers, the Ganges and the Brahmaputra Rivers (Kravtsova et al. 2008).

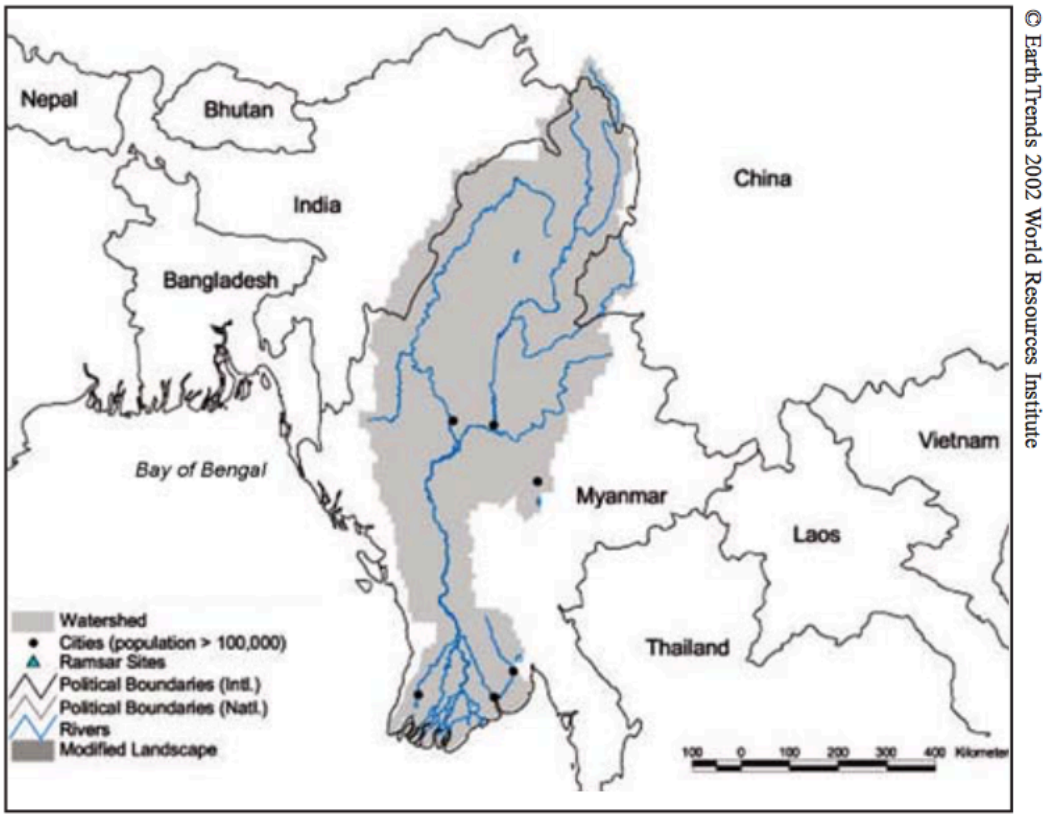

Figure 9: The Irrawaddy River Basin (KDNG 2007)

3.3 River Tributaries

The Irrawaddy River is formed at the confluence of the N'mai and Mali Rivers. Five main tributaries located within the basin feed into the Irrawaddy south of this point: the Taping River, Shweli River, Myitnge, Mu River, and Chindwin River. An additional three main tributaries are located within the region of the Irrawaddy located in China; these include the Dulong River, the Daying River, and the Ruili River (Yang et al. 2016).

3.4 Sediment Fluxes

The Irrawaddy River carries the fifth-largest suspended load of sediment (265 MT yr^{-1}) and the fourth-highest dissolved load among the world's largest rivers (Robinson et al. 2007). Give the fact that the useful life of a dam is directly proportional to the accumulating speed of sediment deposition behind the dam, the life expectancy and engineering of any dam on the Irrawaddy must take the suspended load of sediment into account. Moreover, engineers and dam specialists must pay special additional to sediment fluxes. As high sediment accumulates behind a dam, the build up can weaken the dam. Equally significant, with sediment trapped behind the dam, lower sediment supply dramatically compromises the subaqueous delta areas in front of the dam (Bangqui Hu et al. 2009). These conditions are known to create a series of profound morphological, ecological, geological changes in the estuary, delta, and coastal sea (Bangqui Hu et al. 2009).

Delivered from the Himalayan Mountains down to the Gulf of Martaban, the Irrawaddy River water and sediment, along with the corresponding understanding that comes with it (e.g. characteristics, fluxes, mineralogy), coincides with the tectonic uplift impact on “biogeochemical cycles,” as well as anthropogenic effects on sediment yields and fluxes (Robinson et al. 2007). Following the monsoonal climate and rainfall patterns, during the rainy season from around June to November, the river drains the majority of its sediment discharge (92%) as well as its water volume (80%) (Hedley et al. 2009).

The river carries mainly fine-grained sediments, however it is also quite effective at carrying larger-bulk sediments as well, which contributes to the progradation of the

coastline along the Gulf of Martaban (Hedley et al. 2009). In contrast to a majority of the world's great rivers, the Irrawaddy has had a steady increase in the amount of sediment being delivered towards the Gulf of Martaban and in turn, the Andaman Sea, due to a lack of dams on the main channel as well as the effects of drastic increases in population and the associated changes in land use (Robinson et al. 2007). As compared to early original data on the fluxes within the Irrawaddy River by Gordon, the most recent study would otherwise state that that the past flux of 261 MT yr^{-1} is a strong miscalculation and that the sediment flux for the river is more along the lines of 364 ± 60 MT yr^{-1}. These realities firmly situate the Irrawaddy River's sediment measures as being the third largest sediment load in the world (Robinson et al. 2007).

3.5 Aquatic Life

Given origin, size, climate, and geography along the river, the Irrawaddy River and its tributaries boast high diversity of fish and aquatic life within this particular region of Southeast Asia. The Irrawaddy and its upper portions that extend north into China have a fish assemblage of 85 different recorded species within 8 orders, 20 families, and 51 genera (Yang et al. 2016). Out of the 85 assemblages, there were 76 indigenous species within 42 genera as well as 9 non-native species within 9 genera with 40 of these total species being completely native to the entire Irrawaddy basin (Yang et al. 2016). The river is also home to a rare species of dolphin, the Irrawaddy Dolphin.

Chapter Four: Social and Political Context

4.1 Brief History of the Political System

The country of Myanmar has undergone and, indeed, withstood vast changes in terms of its political realm: from asserting its independence from Great Britain in 1948, to becoming a military-led state, and later through transition from that of a military dictatorship towards National League for Democracy (NLD), a parliamentary republic, beginning in 1990 (CIA). During 1994, there were four different groups that came forward with strong political opinions: the military, the National League for Democracy, the New Democracy Movement, and the Armed Opposition (Smith 1994). The high variance in political and social opinion was and continues to the present.

Military force within Myanmar has been a pressing issue throughout the government and parliament throughout history and the present-day. Myanmar's history has been subject to issues of turmoil and unrest in terms of militaristic rule versus that of the newer democracy. However, under the NLD, Myanmar has been making greater strides to preserve the relationship with the governmental class of people and the general population as well as the sustainability of the country as a whole. As far as conservation goes, there have been 16 major laws created for the purpose of resource and ecological protection and sustainability from 1951 to 2006 (Sovacool 2012; Simmance 2013; Figure 10).

4.2 Ethnicities and Religious Diversity

The main religion throughout Myanmar is Buddhism (87.9%), but there is still a presence of Christianity (6.2%), Muslim (4.3%), Animist (0.8%), Hindu (0.5%), other (0.2%), and none (0.1%) (CIA). Myanmar consists primarily of the Burman ethnicity at 68%, however, the other ethnic groups include the Shan (9%), Karen (7%), Rakhine (4%), Chinese (3%), Indian (2%), Mon (2%), and other (5%) (CIA). The array of ethnicities and religions within Myanmar is accompanied by a high variance in public opinions and thoughts. This leads to higher levels of violence and turmoil amongst the people of Myanmar. There are differing public opinions among the general population and a large divide between the classes, lending the momentum and pressure to a great social divide and increasingly dramatic socioeconomic disparities across the region, even given the rural nature of Myanmar.

Name	Year	Description
Factory Act	1951	To make effective arrangements for the dispoal of waste in every factory, promote health and cleanliness, and provide precaution against danger.
Public Health Law	1972	To promote and safeguard public health and take necessary measures to ensure environmental health.
Territorial Sea and Maritime Zone Law	1977	To implement the United Nations Law of the Sea treaty defining maritime and contiguous zones and preserving and protecting the marine environment.
Fishing Rights of Foreign Vessels Law	1989	To conserve fisheries and enable the particiaption of foreign investors in fishery operations.
Marine Fisheries Law	1990	To conserve and enable systematic operation of fisheries.
Pesticide Law	1990	To direct the Myanmar Agriculture Service to analyse and test pesticides, and to undertake bio-efficacy trials on crops.
Private Industrial Enterprise Law	1990	To avoid environmental pollution in the face of rural development and industrialization, and to promote the use of energy in the most economical matter.
Forestry Law	1992	To prevent dangers of destruction to forests and biodiversity and to conserce and establish forest plantations.
Plant Pest Quarantine Law	1993	To prevent prests from entering Myanmar by any means and to suppress their spread.
Development of Border Areas and Natoinal Races Law	1993	To cherish and preseeve the cultural and custons of national races and to preserve the tranquility of border areas.
National Environmental Policy	1994	To establish sound environmental policies in the utilization of water, land, forests, minerals resources and other natural resources to preserve the natural environment and prevent its degradation.
Protection of Wildlife and Wild Plants and Conservation of Natural Areas Law	1994	To protect wildlife, wild plants and conserve natural areas, to contribute to the works of natural scientific research and to establish a network of zoological and botanical gardens.
Myanmar Mines Law	1996	To implement mineral resources and protect environmental conservation works that may have detrimental effects from mining operations.
Protection and Preservation of Cultural Heritage Regions Laws	1998	To protect cultural heritage from natural disasters and man-made destruction.
Fertilizer Law	2002	To boost development of agriculture, control ferilizers, and facilitate soil conservation.
Conservation of Water Resources and Rivers Law	2006	To conserve and protect water resources and rivers for beneficial utilization by the public, and to prevent serious environmental contamination.

Figure 10: Policies and Laws Created for Sustainability in Myanmar (Simmance 2013)

4.3 Myanmar's Economic Sector

Myanmar is home to a high number of valuable natural resources that have caught the eye of foreign investors due to a closeness to markets and a young eager workforce. Investors are intrigued by the energy sector, information technology (IT), and food and beverages (CIA). From the 2013 fiscal year to the 2014 fiscal year, pledged investments in Myanmar grew from $4.1 billion to $8.1 billion (CIA). Myanmar as a whole is an agricultural-based country with 26.3% of the GDP being attributed to the agricultural realm and 70% of the labor force being involved in agriculture (CIA). However, approximately one-quarter of the population of Myanmar remains in poverty, making it one of the poorest countries within Asia. Given the reality of barely half of the population having access to power, there is a strong need for energy in this area. This energy gap makes the Irrawaddy Dam Project look both socially and economically favorable for the country of Myanmar.

4.4 Foreign Political Involvement/Background, and Social Implications

Neighboring to the northeast of Myanmar, the Chinese government is a proponent for its domestic companies within to invest in foreign markets through the "go out" policy. The "go out" policy entails the government and domestic companies going out globally and investing heavily into various markets that will provide an increase in a needed commodity (in this case, hydroelectricity) that is, then, transferred back to the mother country. China has invested heavily in hydropower projects throughout Asia.

China's plan for the framework of the situation had a background following their foreign policy of:

> "We will enhance unity with other developing countries, deepen traditional friendship, expand mutually beneficial cooperation, [and] sincerely help the other developing countries achieve independent development by providing aid and making investment and uphold their legitimate rights and interests as well as their common interests," (Weatherby 2012).

True to this explicit policy position and economic interest, China is the most involved nation in the country of Myanmar and, moreover, the main party to the proposed construction and operation of dams along the Irrawaddy River. China has supplied the majority of the funding in both designing and the construction of over twenty hydropower projects, within Myanmar. These hydropower proposals and projects are primarily focused on claiming the resulting hydropower for China and in designing the exporting of the power, given the reality that these dams are engineered with the capacity to reroute energy back to the China. In the aggregate, the imported hydroelectric power thus derived is equal to the amount of energy produced by the famed Chinese Three Gorges dam.

One of the biggest issues at play in the relationship between Myanmar and China is a relatively new and inherently-weak, inexperienced Myanmar government in contrast to the perennial powerhouse of China. Myanmar's position and political system may be considered weak given its structure as a fragmented system that relies heavily on local governments to enforce the rule of central government (Weatherby 2012). Furthermore,

until as recently as 2010, Myanmar's political system has historically been one of military rule, leaving the region unified but unstable (Weatherby 2012).

Dam proposals began to take root just prior to the transition to elected rule of law, bringing with it fragmented and divided opinions and viewpoints. This unpredictable political landscape, ripe with a multiplicity of opinions, lent itself to China's move to capture Myanmar's most valued commodity – the Irrawaddy. China began to implement Build-Operate-Transfer (BOT) in which they fund and build the dam, followed by owning and operating for a specific time period, after which the ownership is transferred to the host country for the remaining longevity of the project (Weatherby 2012).

While the waterways of Myanmar are an attractive investment, China bears minimal risk when it comes to the livelihood of the river, region, and people. China is one of the largest energy consumers in the world, and with that comes the search for more power – in every regard. With its large untapped source of water and its hydroelectric possibilities, Myanmar's presence in the region made it an attractive and highly-vulnerable political regime as well as an area with a lower carbon footprint and low carbon energy source for China. These factors made it easier for China to be Myanmar's largest foreign investor (Reeves 2015).

China does not just stop at hydropower; Myanmar is a source for oil as well. The recently-opened oil pipeline system from Myanmar to China (owned and operated by China National Petroleum Corporation) is said to be able to transport 442,000 barrels a day across the 771-km distance (Bloomberg 2017; Figure 11). As the dominant party in these agreements between Myanmar and China, the latter –driven by self-interest –is

more concerned about meeting China's energy needs and less concerned about the future needs of Myanmar and its inhabitants (Higgins 2011).

China's mission of singular self-interest is codified and exemplified in the fact that the future Myitsone reservoir is located within ancestral grounds and has the dangerous capacity to flood an area that is equivalent to the size of Singapore and will potentially relocate large masses of people from their land (The Economist 2011). The Myitsone dam will, in fact, submerge both historical and cultural sites upstream from the confluence point (International Rivers 2011). Furthermore, the original estimates projected the Myitsone dam project to only relocate 2,146 people from five villages and move those particular people into model villages that would give them access to power and life supplies. However, to date, a total of 12,000 people (nearly six times the early estimate) from 63 villages have already been relocated. In the final analysis, the Myitsone dam project is likely to force the relocation of more than 20,000 people –nine times the early estimate –who will be strongly affected (International Rivers 2011).

Due to the location of the Myitsone Dam, the Kachin Independence Organization (KIO) has stated that the continued construction of the dam is likely to threaten the traditional livelihoods of the Kachin people – a state within Myanmar (International Rivers 2011). The aforementioned displacement of people disconnects farmer from farm and brings about higher rates of unemployment. The displacement factor coupled with increased foreign labor on or near the dam, has set in motion the reality of the disappearance of traditional jobs, directly affecting the Myanmar people, while at the same time, putting other project jobs in the hands of cheaper imported/relocated Chinese

labor. Therefore, while Myanmar's land, its economy and its people suffer harsh consequences, Chinese workers, companies, and their economy are benefitting.

China's self-motivated tactics don't stop at the disregard for ancestral lands or the displacement and safety if its inhabitants. China has also turned to the use of live-fire exercises near the border that send a message of dominance while also attempting to be sure that Myanmar's instability (political, economic, militaristic, social, and divergent ethnicities) stays within its borders (The Economist 2016). This illustrates the clear message of China's presence: China will achieve its goals while, at the same time, maintaining control of Myanmar's most valuable resources. China has the largest claim to the resulting hydropower from the dam, receiving 80-90%, with the remaining 10% allotted to Myanmar (Ives 2017). Furthermore, according to The New York Times, there is not actually a grid that connects the Myitsone dam project to Myanmar's greater cities and towns (Ives 2017).

With growing unrest over China's dominance with the region, China's only incentive to promote peace or to listen to the home-country's concerns is to maintain the utilitarian survival of the relationship. Yet to truly listen means to understand – and to understand means to respect the heritage and concerns of Myanmar. Hardly China's goal. China's efforts to monetize the Irrawaddy is currently suspended due to a rise in public distress for sustainability and the preservation of land and culture. But it remains a strongly-motivated work in progress.

Figure 11: Pipeline System from the Coast of Myanmar into China (The Economist 2016)

4.5 Stakeholders

The people of Myanmar rightly have concerns regarding population displacement, environmental sustainability, and more importantly, Chinese economic expansion into Myanmar, as well as the impact of Chinese nationals immigrating in large numbers into northern Myanmar (The Economist 2011). While there is longstanding sentiment regarding China's presence and influence in Myanmar, these sentiments are amplified by the feeling of resentment and genuine fear that Myanmar was/is becoming just another Chinese province.

Understandably, the major issue attending to the implementation of the dams along the Irrawaddy is the balance of power among the stakeholders involved. Currently $800 million of the $3.6 billion (estimated completion cost) has been spent for construction of the first of seven, the partially-completed Myitsone dam, of which China Power Investment Corporation (CPI) and Asia World Company (AWC) are the majority stakeholders in this project (Jiangtao 2016). Furthermore, CPI has investors to satisfy which include pivotal China players such as the Three Gorges Dam Corporation and China Development Bank (Jiangtao 2016).

A significant marker of the vastness and the high value of the Irrawaddy project is the fact that CPI, as the principle partner, created yet another entity, the Yunnan Power Investment Company, Ltd., in 2008 with the sole purpose of developing, constructing, and operating projects along the Irrawaddy River (International Rivers 2011). The joint venture between the China Power Investment and Asia World Company is what made the operation of the dam possible, by establishing the management through the Burma branch

of the AWC and Myanmar Electric Power Enterprise (MOEP). (International Rivers 2011). In most cases, MOEP thus far has simply played the role of a shareholder in project investments.

This state of affairs leaves MOEP and Myanmar in tenuous predicament, either in terms of cancelling the dam project or in the event that Myanmar chooses to resume the project under its own funding and control. If MOEP and Myanmar completely cancel the currently-suspended dam project (construction halted 2011, by the military-backed transitional governments yielding to public pressure), they must repay the $800 million. Equally challenging is the path of resuming dam construction: Myanmar will owe a hefty $50 million, in interest alone, due and payable a full year prior to resuming construction (Ives 2017).

From economic, as well as political and sociocultural perspectives, all present paths forward are fraught with grave difficulties. If the dam projects are continued forward, it is highly likely that an even greater ideological division among an already divided country may well ensue, opening the potential for protests, riots, or even larger issues regarding the livelihood of the river. (Jiangtao 2016; Ives 2017).

The pivotal question remains: Will Myanmar choose a sustainable river or a sustainable relationship with China?

Chapter Five: Foreign Investment

5.1 Chinese Hydropower Investments

During 2015, China invested $102 billion into renewable energy sources, making China itself the top investor for renewables in the world (Frankfurt School - UNEP 2016; Figure 12). As China's second biggest trading partner, Myanmar itself enjoyed $1.6 billion of Chinese investments from 2004-2010. During the same period, other highly-active targets for Chinese investments included the following: Russia ($2.5 billion), Canada ($2.9 billion), United States ($3.4 billion), Singapore ($4.7 billion), South Africa ($5.8 billion), Australia ($6.97 billion), British Virgin Islands ($13.9 billion), Cayman Islands ($27.3 billion), and Hong Kong ($139.5 billion) (Naidu-Ghelani 2012).

Even a cursory analysis provides the perspective that China, once an isolated, self-contained sleeping giant on the world scene, is rapidly emerging as a world-class and aggressive international investor. As a country, China has truly turned to investing its money into foreign markets that not only produce a high rate of consistent return but also provide solid opportunities to seek dominance, supply its energy needs, and access the trade relationships and specific goods or services that increase its status, its dominance and/or its livelihood. Although China invests relatively heavily in a multitude of countries around the world, a number of its top investment targets are more accurately categorized as peripheral, or less developed, countries or regions (Reeves 2015). In keeping with the investing policies of other world leaders, China has turned to investing

more heavily into developing countries, rather than developed nations (Frankfurt School - UNEP 2016).

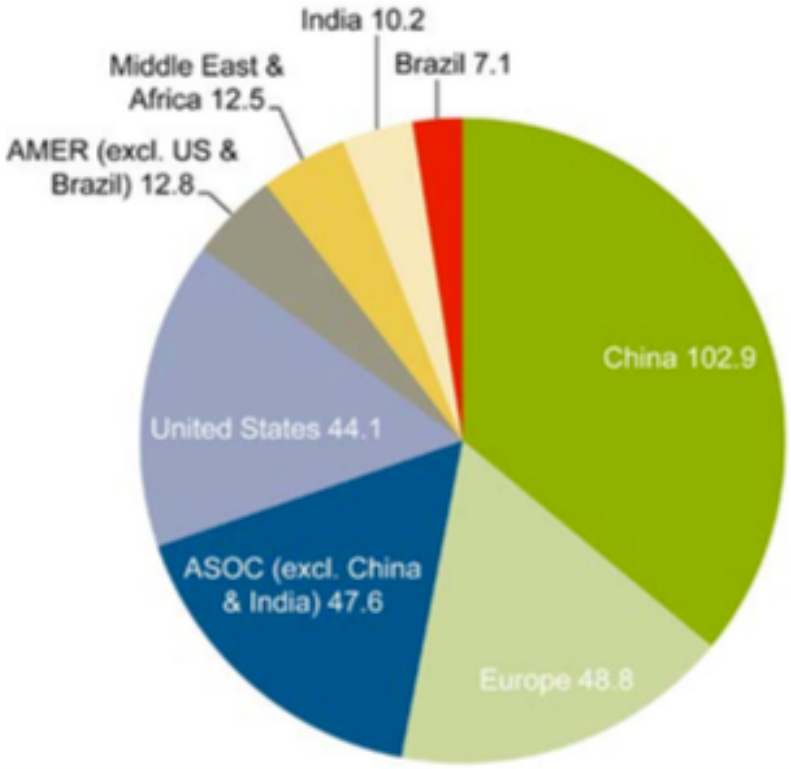

Figure 12: Global Investment in Renewable Energy in 2015 ($BN) (UNEP 2016)

Chapter Six: The Irrawaddy River Dam Project

6.1 Background

Hydropower is the main source of energy in Myanmar (Figure 13). This power alone counts for 75.2% of the entirety of installed capacity, generating Myanmar's standing within the top 20 in relation to the world comparison of hydropower (CIA). Luckily, the Irrawaddy sediment supply to its mouth, the Gulf of Martaban, is currently not heavily affected by the damming of the river. However, given the volume of proposed dams likely to be constructed, it is probable that the sediment supply would otherwise, when completed, begin to alter substantially over time.

At this time there are no major dams on the main channel. However, a series of embankments designed to protect agricultural land could potentially flood. The Myitsone dam that is set to be built and completed in 2018 on the confluence of the Irrawaddy and the Chindwin River and will have a 6000 MW capacity (Simmance 2013). Hydropower on the Irrawaddy varies from many situations because of the fact that the dams are funded heavily or fully by foreign donors such as, China. The interest of China in the development of hydropower along the Irrawaddy centers on the Chinese influence on economic growth and political balance in the region (Hennig 2016). The development of hydropower projects within large river basins that cross country boundaries has a plethora of effects on the region and within the home country, as well as the balance of local and foreign interests economically, policy and commerce on the river as a whole, including

upstream and downstream regimes, social and cultural balance if there is a multi-ethnic region, and resource control (Hennig 2016).

Existing HP projects (≥50 MW) in the transnational Ayeyarwady basin and its major characteristics.

	Name	State	Subbasin	Begin of operation	Funding country/organization
1	Daying 4	CH	Daying/Taiping	2009	China
2	Yewya	MY	Myityinge	2010	China & Myanmar
3	Shweli 1	MY	Longjiang/Shweli	2008	China
4	Sujiahekou	CH	Daying/Taiping	2013	China
5	Taiping (Darpein) 1	MY	Daying/Taiping	2011	China
6	Longjiang	CH	Longjiang/Shweli	2010	China
7	Daying 3	CH	Daying/Taiping	2006	China
8	Nabang	CH	Mongnai/Molechang	2012	China
9	Nongling 2	CH	Longjiang/Shweli	2009	China
10	Songshanhekou	CH	Daying/Taiping	2012	China
11	Dengke	CH	Longjiang/Shweli	2010	China
12	Lazhai	CH	Longjiang/Shweli	2008	China
13	Liangwai	CH	Daying/Taiping	2016	China
14	Daying 1	CH	Daying/Taiping	2007	China
15	Chipwinge	MY	N'mai Hka	2013	China
16	Tenglongqiao 2	CH	Longjiang/Shweli	2010	China
17	Mone	MY	Mone	2004	China & Myanmar
18	Mongnai 3 new	CH	Mongnai/Molechang	2016	China
19	KyeeOhnKyeeWa	MY	Mone	2012	China & Myanmar
20	Sancha	CH	Daying/Taiping	2015	China
21	Daying 2	CH	Daying/Taiping	2007	China
22	MongDian 2	CH	Namtabet/Namtabai	2004	China
23	Monga 6 & MongDia	CH	Namtabet/Namtabai	2008	China
24	Husong	CH	Daying/Taiping	1993	China
25	Kinda	MY	Panlaung	1985	

Figure 13: Existing Dam Projects Along the Transnational Irrawaddy Basin (Hennig 2016)

6.2 Size

Myanmar has the potential to reach a 40,000 MW hydropower capacity (Simmance 2013). The $3.6 billion and 6,000 megawatt Myitsone dam is one of the seven proposed dams on the Irrawaddy River and is set for a completion date in 2018

(Figure 14; Figure 15). The Myitsone dam is planned to export approximately 90 percent of all electricity produced to China.

2005	CPI and Asia World establish joint venture to build hydropower projects in seven locations along Mali Hka and Nmai Hka rivers.
2006	On December 28th, The Ministry of Electric Power-1 and China Power Investment Corporation sign an MoU.
2007	In May, agreement to build the 7 dams is signed. In June and July, KIO chairman approaches Yunnan Province State Council (6/11), Head of State Senior General Than Shwe (7/6) and Head OF Myanmar Military Northern Command in Kachin State (letter of Tanghpre villagers, 7/6). In December, Changjiang Survey, Planning, Design and Research (CSPDR) completes planning report for the feasibility of the hydropower projects.
2008	In March, terms of reference for the EIA is completed, and subsequently approved. In December, Yunnan Power Investment Co Ltd is created for the primary purpose of the development, construction and operation of hydropower projects on the Irrawaddy. On December 24th, BANCA and CPI sign an agreement to conduct an EIA special investigation.
2009	From January to July, Chinese and Burmese experts from the Changjiang Survey, Planning, Design and Research Co Ltd, Chinese Academy of Sciences, Ministry of Water Resources, South China Botanical Garden of the Chinese Academy of Sciences, South China Institute of Endangered Animals, and Burma's Biodiversity and Nature Conservation Association conduct a special investigation on the upper Irrawaddy. In August, notes on the CPI website reflect that site management was concerned about an outbreak in armed conflict in parts of Burma. Instead of withdrawing the 1,000 or so Chinese workers, they instigate a range of safety measures. In October, the baseline environmental impact assessment by BANCA is finalized. In December, stage 1 (out of a total of 5 construction stages) begins on the Myitsone Dam site. The resettlement of people begins.

Figure 14: Approximate Timeline for the Myitsone Dam (International Rivers 2011)

2010	In March, CISPDR finalizes the EIA Report.[9] In April, four explosions occur at the Myitsone Dam site - three at the worksite and one at the workers housing area (as reported by Xinhua, April 17). Other media reports that the blasts killed three people and injured 20. In September, Government declares that despite the 1994 Ceasefire Agreement with the KIO, communications and cooperation would be halted. KIO invites CPI to discussion and received no response.
2011	In January, developers finalize the overall EIA for hydropower projects on the upper Irrawaddy. In March, security measures tighten at the dam site, KIO declares itself not responsible for civil war if the military government invades KIO area. The Chairman of KIO also sends a letter to the Chairman of Chinese Communist Party (3/16). On June 9th, fighting erupts, affecting the construction site. In July, full scale construction resumes. Electric Power 1 Minister Zaw Min, under a pen name, describes in the *New Light of Myanmar* the benefits of the dam and dismisses any environmental impacts.[10] In August, Daw Aung San Suu Kyi publishes letter: Appeal to Save the Irrawaddy. On September 17th, the Burmese government hosts a workshop in Naypyidaw to discuss impact of hydropower projects on the Irrawaddy River.
2018	Target date for project completion.

Figure 14 (Continued): Approximate Timeline for the Myitsone Dam (International Rivers 2011)

Future HP projects (≥50 MW) in the transnational Ayeyarwady basin					
No.	Name	State	River	MW	Status
Upper Ayeyarwady cascade					
1	Myitsone	MY	Ayeyarwady	6000	suspended
2	Chibwe	MY	N'Mai Hka	3400	halted
3	Kaunglangphu	MY	N'Mai Hka	2700	
4	Hpizaw	MY	N'Mai Hka	2000	
5	Laiza	MY	Mali Hka	1900	
6	Wutsok	MY	N'Mai Hka	1800	
7	Yenam	MY	N'Mai Hka	1200	

Figure 15: Future Dam Projects Along the Transnational Irrawaddy Basin (Hennig 2016)

6.3 Effects of the Dam Project

Within the realm of the implementation of dams in Asia and especially within the Irrawaddy, one significant issue is that of the threat to species diversity. The addition of a dam on the river will automatically restrict the path of fish, as well as create reaches of the river promoting a lotic environment that fish may not be capable of thriving in (Yang et al. 2016). With the plan to design and build seven dams, there is a strong threat to the flow regime of the river, as well as to the ecology of the river (Simmance 2013). Given significant changes of the flow regime, numerous changes can likewise be expected to the floodplains, delta, and ecosystem around and within the immediate environment.

Taking the specific example of the Myitsone dam, China – as the funding and technical source of the dam – gains control of the condition and circumstances of the entire Irrawaddy river, with immediate control over a majority of the population and livelihood of the people of Myanmar (Simmance 2013). Such as David attempting to tell

Goliath to wear different sandals, Myanmar's weak central government will likely be incapable of dictating the conditions to China over the Irrawaddy dams.

Flow dynamics such as daily flow and water velocity, as well as sediment loads for the Irrawaddy can be anticipated to be greatly affected due to stabilizing the dry and monsoonal seasons (Simmance 2013). One of the most dramatic aspects arising with the implementation of dams is the resettlement of a significant portion of Myanmar's population.

The large scale of the dams currently being proposed and constructed leads to major constraints on the flow regime for the Irrawaddy River, which has the potential to affect the flood pulse sizes, overall geomorphology of the river, sediment load, ecology, and much more. One of the biggest and most controversial features is that the proposed dams on the Irrawaddy River are a substantial distance from the demand sources, China and India, chief consumers of the hydropower which will be produced from the dams. This automatically means that the energy produced must travel a great distance, making the export journey vulnerable to network issues and potential setbacks (Hennig 2016).

Chapter Seven: Implications Involved in Dam Building: Economic, Environmental, and Social

7.1 Irrawaddy Implications

The Irrawaddy River acts as the spine of Myanmar. Beyond its role as the major channel to transport goods and services, its waterways also provide necessary nutrients to all regions downstream. With the delta being home to 60% of all rice production in the country, flow changes are bound to adversely affect the water's nutrients. Downstream sediments, both organic and inorganic, are dramatically altered, impacting the ecology, aquatic habitat, and water quality (Atkins). Such nutrient-deficient irrigation would result in steeply-reduced production, delivering serious economic losses that would impact the millions of farmers in the area (Burma Rivers Network 2008). The disconnect between the indigenous people of Myanmar and the governing classes, is strikingly exemplified by the lack of dialogue of the unintended consequences of these dam projects on the life surrounding the Irrawaddy River. Few of those making political decisions have their own lived experience of the river or of the people of Myanmar who glean their subsistence lifestyle around the seasonal river flows and fluxes. Any alteration of seasonal flows would decrease the rice farming opportunities that the people depend on. Although the Irrawaddy dams are not yet in commission, it is not too bold of a statement to state that they will alter the rice farming capabilities of Myanmar.

Grain would not be the only loss. Similarly, fisheries would be heavily affected by the lack of nutrients, plus the additional impediments of blocking of migratory routes, slight lowering of water temperatures, and alterations in the seasonal cycles that the river naturally takes (Burma Rivers Network 2008). The river is home to various migratory fish, of which, the indigenous people of Myanmar depend on for their livelihood. Introduction of dams will block their migratory routes and result in a decline in the populations of those fish, likewise decreasing livelihood and food supply of those dependent on the river. In addition, the region would likely face water shortages throughout, which would lead to further practical declines in terms of transportation of goods and services.

On an even more alarming scale, when natural flows of water are restricted, salt water intrusions into the areas near and around the delta would take place. These salt water intrusions have the capacity to flood upstream areas along the river, reaching a level of incursion as large as 260 km^2, most of which is currently characterized as rainforest (Burma Rivers Network 2008). Some of the areas that are likely to flood are among the most biodiverse in the region and contain many endangered species, such as the Irrawaddy Dolphin. Aside from the effect of upstream flooding, salt water intrusion inhibits the river as a drinking water source, destroys current farming and irrigation strategies along the river, and effects the livelihood of the Irrawaddy Dolphin and other freshwater assemblages as they have known it.

As in most populated regions around major rivers and rich delta basins, the threat of ecological damage has been a present and persistent issue along the Irrawaddy since

increased deforestation and industrialization began actively taking place on a large scale, in the recent past. The ecosystems and population near the river have also seen effects from water pollution, increased saline intrusion, and increased sandbanks (International Rivers 2011). With increased growth issues from the implementation of dams, the ability for the river to respond and accommodate to natural processes has dramatically decreased.

Downstream regions are likely to see further heavy decreases in rice and other agricultural product production rates due to changes in water flows as well as a decrease in fish production as natural fish migration routes will end if the Myitsone dam is completed (International Rivers 2011). The regions near the confluence and the Myitsone dam have also seen direct geologic problems ranging from the collapse of a nearby tunnel to recent seismic events (International Rivers 2011). Experts and environmental agencies such as the Biodiversity and Nature Conservation Association (BANCA) have recommended that a possible way to decrease the negative effects of the Myitsone dam would be to diversify and expand the natural infrastructure; e.g., build two smaller hydropowered dams accompanied by two national parks that would provide additional precautionary measures to preserve, protect, and limit destruction of forests; rather than building one imposing 6,000 MW Myitsone dam (International Rivers 2011).

As prefaced above, serious concerns abound for water levels, salt water intrusion, and sediment travel within the river. Among the impeding issues at stake in the future of Myanmar, sediment travel is perhaps the most pressing consideration. After any dam is built and commissioned, sediment begins to settle in the reservoir of the dam, which

causes the floor of the reservoir to rise incrementally and, correspondingly, decreases the carrying capacity of the particular dam over time. This is known for shortening a dam's lifespan significantly. In the case of the Irrawaddy River, with a higher sediment load in transport, this factor predisposes all Irrawaddy dam reservoirs to higher rates of sediment settling and rising with its basin, along with the shortening of the lifespan of any dam under these conditions. Similar issues with sediment load were seen in the example of The Three Gorges Dam on the Yangtze River in China and its halting of nearly half of sediments and nutrients from progressing further downstream to the delta (Handwerk 2006). These particular types of issues have led and continue to lead to major alteration in the geomorphology of the river, increased erosion in the delta and tidal regions, and other changes to the natural flow of the Yangtze River (Handwerk 2006).

From the practical, time-limited perspective of Chinese investors, such aspects of a shortened lifespan is of little concern as Chinese ownership and operation of any commissioned dam on the Irrawaddy River is limited to 50 years – likely leaving Myanmar to acquire the dam in compromised, less-than-ideal working condition than is anticipated or projected by Chinese officials as the first-50-year benefits projected to their advantage. Unmistakably, the lowered life expectancy of the dam would mean less money, less power, and continually-diminished jobs for the people of Myanmar (Weatherby 2012). Even when evaluating the immediate monetary benefit of a completed Myitsone dam, Myanmar would only realize 20% of the revenue and 10% of the hydropower, making not only the long-term benefit difficult to justify, but also calling into question the short-term value (International Rivers 2011).

Chapter 8: Conclusion

8.1 Features of the Resource Curse

In some ways, the Myanmar's efforts to partner with foreign investors to develop the Irrawaddy River is like that of mineral-rich nations afflicted with the resource curse. The term of "the resource curse" has evolved over many iterations of political, social and economic analyses regarding the involvement of developed nations in the redistribution of natural resources from an undeveloped country rich in mineral, oil or gas resources. This concept of resource curse effectively names those conflicts emanating from the untapped power of a great river. By its potential as a clean, renewable power source, a great river - as sure as oil or gas reserves - ignites visions of dam projects designed to capture hydroelectric power, as in the case of China's move to capture hydropower from dam systems on the Irrawaddy. While hydroelectric power, by its nature, is renewable and extracted without diminishing the resource itself, the construction of dams (needed to capture and generate power from water discharge) are themselves highly invasive and intrinsically destructive of the geomorphology of an area, especially one as wide-ranging and expansive as the Irrawaddy basin. Therefore, the concept of resource curse fits well as an analogous tool for analyzing and assessing the complexities of the Irrawaddy dam projects.

The resource curse brings with it high rates of conflict and authoritarianism, along with low rates of economic stability and economic growth. This is because countries with

more natural resources are predisposed to military rule or outside investment. In undeveloped regions the presence of resource riches and the competition for resource control, internal or foreign, often incite conflicts which likewise slow progress.

At its most fundamental level, the curse posits that countries rich in natural resources are more likely to struggle with social, economic, and political challenges (NRGI 2015). This is due to a multiplicity of reasons, but of particular interest in Myanmar's case is internal conflict and foreign involvement. Reflected in Myanmar's history of military rule, weak central government has led to conflict -- rule by strength is not considerate, but rather, inconsiderate and inconsistent. Control of natural resources is a means to power that often includes a wide range of social, economic, and political challenges (NRGI 2015). This is because countries with more natural resources are predisposed to military rule or outside investment.

8.2 The Double Edged Sword

The Irrawaddy dam projects continue to follow the scenario of a double edged sword, alternately favorable or unfavorable, for a multitude of reasons. The reason being that the sustainability of the country, the people, and the river are at stake in this dam-dominated perspective involving the relationship of Myanmar with China. Something that holds true in any of the scenarios surrounding the dam projects is that one of the principals is not going to be pleased with the outcome.

Presenting itself as an opportunity for the home country, China comes forward as an investor to many different countries, including peripheral countries, such as Myanmar,

in a way that promotes an economic growth and enhancement in some way for both or all parties involved.

With the presence of China so relevant to the current status of Myanmar, it is apparent that China has brought forth, or influenced in some regard, violence within Myanmar, illegal activities, a quicker degradation of the environment, and the exploitation of the resources contained in Myanmar (Reeves 2015). The economic network that China is working towards through its foreign relations and investments lead to disproportionate gains of all parties involved, including: economic increases, political involvement, and social gains, that all have a tendency to end with the larger straw in the hands of China (Reeves 2015). The issue with this is that the way in which China approaches its foreign investments, just as with Myanmar, leads to a negative context amongst people in the home country. In the example of Myanmar, there was little to no communication or presenting or the projects with the people outside of government and military, along with the dam projects leading to relocation of people, loss of land, deforestation, loss of natural resources, and above all else, change in the daily life and livelihood of the people who inhabit the Irrawaddy region.

8.3 The Conundrum of Neocolonial Power

Myanmar's dam projects, with the multiple layers of involvement and entanglements with China, raise new questions about the complex issues that befall underdeveloped, resource-rich nations in dealing with technologically-advanced, politically-sophisticated, resource-seeking neighbors. In many regards, the issues are as

old as history itself: the perennial challenge that occurs when the desires of a mighty group, with resource needs, become fixed on the availability of resources, in the territory of a weaker group. By whatever name, colonialism has examples that range from the beginnings of recorded history to present times (Fischer 2013).

In early times, these acquisitions often took the form of conquest and outright subjugation of the local population. In the age of exploration, the methods might have been more restrained and tempered by distance, yet typically resulted in widespread immigration to establish a more-advanced, occupying foreign power in a new land. As transportation, diplomacy and commerce advanced, the same goals were accomplished by negotiation in barter, in trade arrangements or in treaties. Yet, in the final analysis, the net effect was similar and could be accurately characterized as "economic exchange between core (rich) and periphery (poor) countries," a defining feature of the dependency school of thought advanced by Andre Gunder Frank (Reid-Henry 2012).

The significance of these theoretical models is to provide a lens through which it is possible to understand and to interpret key aspects of the contemporary wave of resource appropriation around the globe. While these incursions of technologically-advanced interests into resource-rich undeveloped nations can mask as the infusion of progress into a poor region, rarely is the equation that simple or egalitarian. Indeed, the recent political profile of Myanmar easily begs the question of which of the governing groups has been in a position to profit from the close ties to China and its quest of hydroelectric power. As has been observed in countless other cases of resource extraction in undeveloped nations, the exploitation of poor countries by rich ones is

possible only because the ruling elites in poor countries have something to gain (Reid-Henry 2012).

While favorite theories and various analytical tools of the social scientist wax and wane on the international political and economic scene, the challenges of uneven starting points – between highly-developed nations and undeveloped regions – remain. The inherent structural disparities in the ascendency of global capitalism continue unabated. These disparities lie at the heart of the challenges now facing Myanmar as it must come to terms with the Irrawaddy River dam projects and both the intended and the unintended consequences.

One of the clear perspectives gaining traction in this discussion is application of the resource curse, as understood as the social, political and economic challenges of natural resource wealth (NRGI 2015) While this has most often been applied to resources of oil-, gas- or mineral-rich countries, the application of this model is equally relevant to the region of a great river, such as the Irrawaddy, which holds in its steady water discharge, its remarkable length and its accessible terrain, the potential for massive quantities of hydroelectric power when dammed. And, much like the impact of the depletion index always present in the extraction of a finite natural resource (oil, gas, mineral), the massive changes wrought by damming of a great river (population relocation, deforestation, fish and wildlife changes, habitat, herd and agriculture losses) must be understood and calculated as a significant measure of the risk/reward or cost/benefit analysis of such a behemoth undertaking.

The fact of the matter is that China's proposal for various hydroelectric power projects along the Irrawaddy basin can be characterized as an issue of colonialization on the modern scale. From any perspective, it is within the data to see this as a case study for power-hungry and dominant counties investing time, energy, and money into developing countries for the sake of subjugating most, if not all, of their major resources. The home country sees the impending effects on all sides of the spectrum: socially, politically, economically, and physically, whether it is in the immediate or far future.

8.4 Future Analyses

Given the complexities and the inalterable changes inherent in these large dam projects, scientists and social scientists alike must apply their expertise and the tools of their disciplines to thorough analyses of these factors. The imperatives for this level of study are not new. However, as the requirements of clean energy production rises exponentially to address the ever-mounting demands of global technology, the country or the region of the globe with the highest energy access will have a substantial advantage in every measurable scale. As the appetite for clean energy grows, the urgency and critical importance of increasingly precise models for assessing the consequences of major projects – especially those affecting massive changes across a large geographical range, with inherent geopolitical consequences – will grow exponentially. This is the consummate lesson that Myanmar and the many challenges of the Irrawaddy River dam projects have to teach the world.

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Vita

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